Laboratory Simulations of the Titan Surface to Elucidate the Huygens Probe GCMS Observations. M. G. Trainer[1], H. B. Niemann[1], D. N. Harpold[1], S. K. Atreya[2], T. C. Owen[3], and W. T. Kasprzak[1], [1]NASA Goddard space Flight Center, Code 699, Greenbelt, MD 20771, melissa.trainer@nasa.gov, [2]Department of Atmospheric, Oceanic and Space Sciences, University of Michigan, Ann Arbor, MI 48109, [3]Institute for Astronomy, University of Hawaii, Honolulu, HI 96822.

Introduction: The Cassini/Huygens mission has vastly increased the information we have available to study Saturn's moon Titan. The complete mission has included an array of observational methods including remote sensing techniques, upper atmosphere in-situ sampling, and the descent of the Huygens probe directly through the atmosphere to the surface [1,2]. The instruments on the Huygens probe remain the only source of in-situ measurements at the surface of Titan, and work evaluating these measurements to create a picture of the surface environment is ongoing. In particular, the Gas Chromatograph Mass Spectrometer (GCMS) experiment on Huygens found that although there were no heavy hydrocarbons detected in the lower atmosphere, a rich spectrum of mass peaks arose once the probe landed on the surface [3,4]. However, to date it has not been possible to extract the identity and abundances of the many minor components of the spectra due to a lack of temperature- and instrument-appropriate data for the relevant species.

We are performing laboratory studies designed to elucidate the spectrum collected on Titan's surface, utilizing a cryogenic chamber maintained at appropriate temperature and pressure conditions. The experiments will simulate the temperature rise experienced by the surface, which led to an enhanced signal of volatiles detected by the Huygens GCMS. The objective of this study is to examine the characteristics of various surface analogs as measured by the Huygens GCMS flight spare instrument, which is currently housed in our laboratory at NASA Goddard Space Flight Center (GSFC). This identification cannot be adequately accomplished through theoretical work alone since the thermodynamic properties of many species at these temperatures (94 K, HASI measurement [5]) are not known.

Huygens GCMS Surface Spectrum: After a 2.5 hour parachute descent, the probe landed safely on the surface of Titan and continued collecting and transmitting data for another 70 min. The averaged mass spectrum collected on the surface (Fig.1) shows that several compounds were detected by the instrument, many of which were not measured in the atmospheric sample prior to landing [4]. These data are likely a result of warming of the surface by the probe and the subsequent evolution of volatile species from the surface. For example, upon landing the partial pressure of CH_4 was enhanced in the atmosphere relative to N_2.

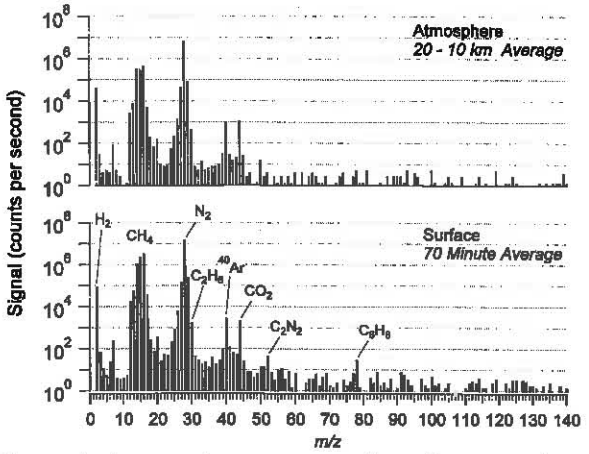

Figure 1. Averaged mass spectra from the troposphere at ~20 to 10 km altitude and ~500 to 900 hPa ambient pressure, compared to the averaged surface spectrum, at 1500 hPa.

Yet, there has been no definitive identification of the surface composition represented by this spectrum. More details on the evolution of species upon probe landing can be found in Niemann et al. (2010) [4].

Experimental Design: The cryocell has been designed to provide an appropriate simulation of the temperature and pressure conditions existing on the Titan surface. The gas pressure in the cell is controllable over a range from ultra high vacuum to the surface pressure on Titan (1500 hPa). The sample plate and GCMS inlet are independently temperature controlled across a range of 90 – 393 K. This will allow for both the simulation of the cold surface temperatures and for the baking of the cell to remove contaminants. During experiments a 1500 hPa atmosphere of 5% CH_4/95% N_2, reproducing the Titan surface atmosphere will be added to the cell. Temperature tests will be performed to understand the effect of the probe landing on the surface and stimulating the release of volatiles. The temperature-dependent profiles will help in the interpretation of the surface results, since the exact temperature at the point of contact of the probe and the surface are not known [6].

The simulation chamber is used to generate surface analogs. The sample plate can be cooled to 94 K or slightly below, close to the temperature of Titan's sur-

face. Species of interest are deposited on the substrate plate within the chamber, and vapor pressures and desorption profiles are studied as a function of surface and inlet temperature. The objective is to obtain a mass spectral signature, sensitivity, and transfer function for each of the surface analogs.

Surface analogs to be studied include single organic components, informed by known photochemical models as well as preliminary analysis of the surface spectrum. Complex surface analogs such as H_2O/NH_3 ices, organic mixtures, and atmospheric haze analogs will also be studied. Measurement of the volatiles above the surface will be correlated with the known composition of the surface analog, and used to contribute to the present understanding of the chemical composition of Titan's surface.

References:

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